ITNAC

INTERNATIONAL TELECOMMUNICATION NETWORKS AND APPLICATIONS CONFERENCE

ITNAC 2025

Conference »Program

2025 IEEE 35th International Telecommunication Networks and Applications Conference (ITNAC) Program

S7: The last paper presentation ends before (10:30) the session end time of 11:00.

S9: The last paper presentation ends before (14:30) the session end time of 15:00.

S12: The last paper presentation ends before (16:36) the session end time of 17:00.

S13: The last paper presentation ends before (16:30) the session end time of 17:00.

Time (Auckland)	E6	E7	E5	Foyer of Rātā | Engineering core	Elsewhere
Tuesday, November 25					
16:00-18:00	**WR**: *Welcome Reception*				

Time (Auckland)	E6	E7	E5	Foyer of Rātā | Engineering core	Elsewhere
Wednesday, November 26					
08:30-09:00	**R1**: *Registration*				
09:00-10:30	**S1**: *Session 1: Cyber Security*	**S2**: *Session 2: Quantum Networks*			
10:30-11:00				**MT1**: *Morning Tea*	
11:00-11:45	**K1**: *Opening Keynote - Systems and Simulation Toolkits for Building and Evaluating Solutions for Next-Gen Cloud and Quantum Computing*				
11:45-12:30	**K2**: *Keynote - Next-Generation Wi-Fi: Performance Issues and Research Challenges*				
12:30-13:30				**L1**: *Lunch*	
13:30-15:00	**WS1**: *Workshop: Open RAN Security and Privacy: Opportunities and Challenges*				
15:00-15:30	**AT1**: *Afternoon Tea*				
15:30-17:00	**S3**: *Session 3: Networks and General*	**S4**: *Session 4: Network Applications*			
17:00-17:30					

Time (Auckland)	E6	E7	E5	Foyer of Rātā | Engineering core	Elsewhere
Thursday, November 27					
09:00-11:00	**S5**: *Session 5: Terrestrial and Non-Terrestrial Networks*	**S6**: *Session 6: 5G/6G technologies*			
11:00-11:30				**MT2**: *Morning Tea*	
11:30-12:15	**K3**: *Keynote - From Clouds for 5G Systems to Clouds for 6G Systems: A Bumpy Road Ahead*				
12:30-13:30				**L2**: *Lunch*	
13:30-17:30	**T1**: *Conference Tour*				
18:30-22:00	**D1**: *Conference Dinner*				

Time (Auckland)	E6	E7	E5	Foyer of Rātā | Engineering core	Elsewhere
Friday, November 28					
09:00-11:00	**S7**: *Session 7: 5G/6G*	**S8**: *Session 8: Cybersecurity*			
11:00-11:30				**MT3**: *Morning Tea*	
11:30-12:15	**K4**: *Keynote session: Beyond Electronics: Harnessing Light to Accelerate AI Workloads*				
12:30-13:30					**L3**: *Lunch*
13:30-15:00	**S9**: *Session 9: Wireless Networks*	**S10**: *Session 10: Working in Progress - 1*			
15:00-15:30				**AT3**: *Afternoon Tea*	
15:30-17:00	**S11**: *Session 11: Working in Progress - 2*	**S12**: *Session 12: Online session*	**S13**: *Session 13: Online Session - 2*		
17:00-17:15	**CR**: *Closing Remarks*				

Tuesday, November 25 16:00 - 18:00 (Pacific/Auckland)

WR: Welcome Reception

Room: E6

Wednesday, November 26 8:30 - 9:00 (Pacific/Auckland)

R1: Registration

Room: Foyer of Rātā | Engineering core

Venue:

Wednesday, November 26 9:00 - 10:30 (Pacific/Auckland)

S1: Session 1: Cyber Security

Room: E6

9:00 ***A Review of the Use of Large Language Models to Generate Synthetic Cybersecurity Datasets***

Jack Gadsby (CQUniversity, Australia); Fariza Sabrina (Central Queensland University, Australia)

Access to high-quality, realistic datasets is critical for cybersecurity research; however, real-world data is often constrained by privacy, classification, and legal restrictions. These limitations contribute to the outdated, imbalanced, or limited realism of widely available datasets. This paper reviews the emerging use of LLMs as a mechanism for generating synthetic cybersecurity data, with a particular emphasis on augmenting existing datasets. The review identifies phishing emails and system logs as the most suitable data types for LLM-driven augmentation due to their structured, textual nature. Outside the specific cybersecurity domain, LLMs have demonstrated aptitude at generating realistic, label-rich artefacts, addressing challenges such as class imbalance, labelling inconsistency, and limited data diversity. These capabilities could be readily applied to cybersecurity datasets. This review consolidates key studies in the field and identifies future directions for integrating LLMs into cybersecurity dataset pipelines, particularly through automated labelling, metadata enrichment, and hybrid generative architectures.

9:30 ***A Two-Tier Secure Federated Learning Framework with Lightweight Cryptography for Edge-Cloud Collaboration***

Shahid Latif (University of the West of England, United Kingdom (Great Britain) & None, unknown); Djamel Djenouri (UWE, Bristol, United Kingdom (Great Britain))

Large-scale deployments Federated Learning (FL) faces significant challenges in scalability, security, and communication overhead. To tackle these challenges, the paper presents a two-tier secure FL architecture that incorporates edge servers as intermediate aggregators between clients and the cloud. This hierarchical framework enhances scalability and minimizes cloud communication by utilizing edge-level aggregation. Security is maintained with lightweight cryptographic protocols, including X25519 for key exchange, HKDF with BLAKE2b for key derivation, and ChaCha20-Poly1305 for authenticated encryption, ensuring end-to-end confidentiality and integrity of model updates. An experimental evaluation on the MNIST dataset across three deployment scenarios (ranging from 9 to 100 clients) reveals improvements in model accuracy from 93.90% to 96.04%. Communication overhead to the cloud was reduced by up to 90%, and cryptographic overhead remained under 5.3ms per operation. Additionally, the architecture achieved 100% resistance to model poisoning, 97.8% prevention of gradient leakage, and 100% confidentiality preservation. The proposed approach outperformed

existing state-of-the-art methods by a margin of 1.27% to 7.64% and demonstrated a strong balance between performance, security, and communication efficiency in edge-cloud FL environments.

10:00 ***A Serverless Federated Learning Framework with Blockchain and Homomorphic Encryption***

Shahid Latif (University of the West of England, United Kingdom (Great Britain) & None, unknown); Djamel Djenouri (UWE, Bristol, United Kingdom (Great Britain)); Jawad Ahmad (Prince Mohammad Bin Fahd University, Saudi Arabia)

Traditional federated learning (FL) architectures are vulnerable to significant security risks. Centralized servers create single points of failure and are susceptible to adversarial attacks such as model poisoning. Additionally, they lack auditability and do not provide cryptographic privacy during model aggregation. This paper proposes a serverless FL framework that integrates blockchain technology with CKKS homomorphic encryption to address these challenges. The framework utilizes a decentralized consensus mechanism based on Practical Byzantine Fault Tolerance (PBFT), eliminating the need for a central coordinator and ensuring robustness against Byzantine faults. It incorporates CKKS encryption to enable secure aggregation through computation on encrypted gradients, preserving data privacy throughout the training process. Furthermore, it introduces an auditable trust management system using smart contracts for immutable logging and decentralized reputation tracking. Experimental results on the MNIST dataset, with 20% malicious clients, demonstrate that the framework achieves a final global accuracy of 98.68% and attains 100% precision in rejecting malicious updates without false positives. The computational overhead remains practical, with encryption and consensus times of 0.814 sec and 1.695 ms per round, respectively. Compared to existing methods, the proposed approach improves accuracy by 1.68% to 10.68%, demonstrating its effectiveness in enabling secure and privacy-preserving FL.

Wednesday, November 26 9:00 - 10:30 (Pacific/Auckland)

S2: Session 2: Quantum Networks

Room: E7

9:00 ***SPEP: Adaptive Resource Orchestration in Quantum Networks through Strategic Entanglement Pre-Positioning***

Vineet Kumar Dwivedi and Vivek Shukla (National Institute of Technology, Raipur, India); Chandrashekar Jatoth (National Institute of Technology Raipur, India); Rajesh Doriya (National Institute of Technology, India); Rajkumar Buyya (University of Melbourne, Australia)

Quantum networks promise unprecedented capabilities for secure communication and distributed quantum computing through entanglement distribution. However, the fragile nature of quantum entanglement and its exponential decay present significant challenges for efficient resource allocation. This paper introduces SPEP (Strategic Predictive Entanglement Pre-positioning), a novel framework that leverages machine learning techniques to anticipate communication demands and proactively establish entangled links. We implement and evaluate multiple prediction models including LSTM neural networks and ARIMA time series analysis, comparing them against traditional reactive and greedy routing approaches. Through comprehensive simulations across four distinct network topologies with over multiple simulation runs, our SPEP framework demonstrates significant improvement in success rates, 15% reduction in average latency, and 25% better resource utilization compared to baseline methods. The results provide strong evidence that machine learning-driven prediction can significantly enhance quantum network performance, particularly in networks with temporal demand patterns.

9:30 ***Hierarchical Quantum Backbone: A Scalable and Robust Topology for Quantum Network Communication***

Saumya Priyadarshini, Sr (National Institute of Technology, Raipur, India); Chandrashekar Jatoth (National Institute of Technology Raipur, India); Rajesh Doriya (National Institute of Technology, India); Rajkumar Buyya (University of Melbourne, Australia)

The scalability of Quantum Key Distribution (QKD) networks remains a primary challenge for realizing the quantum internet. Although full mesh topologies offer superior performance, their quadratic scaling of quantum links renders them impractical for large-scale deployment. This paper proposes a novel Hierarchical Quantum Backbone (HQB) topology that addresses this challenge. It is being done by employing a hierarchical architecture composed of a core ring of quantum repeaters interconnected with distribution hubs and trusted nodes serving end-users. A stochastic simulation framework incorporating realistic models for channel loss, latency, and quantum bit error rate (QBER) evaluates the design's efficacy. Results demonstrate that HQB reduces the number of quantum links compared to full-mesh networks. The topology supports near-instantaneous, high-rate intra-hub key distribution as well as metropolitan-scale inter-hub rates. This comprehensive analysis confirms HQB as a practical, efficient, and fault-tolerant architecture suitable for scalable quantum network deployment.

10:00 ***Towards Double-Signed DNSSEC for Countering Quantum Threat***

Syed W Shah, Robin Doss, Lei Pan and Dinh Duc Nguyen (Deakin University, Australia); Warren Armstrong (Quintessence Labs, Australia); Praveen Gauravaram (Tata Consultancy Services, Australia)

As a security extension of DNS, DNSSEC is critical to the reliable translation of domain names to IP addresses. This reliability - i.e., authenticity and integrity of translated responses in DNSSEC is underpinned through digital signatures. However, the evolution of Quantum Computers has put conventional digital signatures on the brink of compromise. Given this, NIST has recently selected candidates for \emph{post-quantum} digital signatures that can run on conventional computers but withstand the attacks conducted using the \emph{Quantum Computers}. However, since these post-quantum digital signatures are in infancy, cryptanalysts may have missed some important attacks. Therefore, simply replacing the pre-quantum digital signatures with post-quantum candidates in DNSSEC is deemed a risk until the post-quantum candidates are fully analyzed for security. Given this, the European Union Agency for Cybersecurity (ENISA) recommends using post-quantum candidates in conjunction with pre-quantum digital signatures so that if any plausible attacks are revealed on post-quantum signatures in the near future that could be conducted using classical computers, the existing pre-quantum signatures will continue to offer protection during the interim period until Cryptographically Relevant Quantum Computers (CRQCs) are fully realized. Therefore, we investigate the possibility of using Double-Signatures in DNSSEC, combining a post-quantum digital signature and a classic one. To accomplish this, we built a functional testbed using Docker and Docker networks; we modified the source code of commercial-grade DNSSEC software BIND9 to generate and verify DNSSEC traffic. Through a comprehensive empirical analysis, we show the efficacy of Double-Signed DNSSEC and demonstrate that its implementation is plausible with negligible overhead. Hence, double-signed DNSSEC could be recommended for trials and deployment until CRQCs are fully realized.

Wednesday, November 26 10:30 - 11:00 (Pacific/Auckland)

MT1: Morning Tea

Room: Foyer of Rātā | Engineering core

Wednesday, November 26 11:00 - 11:45 (Pacific/Auckland)

K1: Opening Keynote - Systems and Simulation Toolkits for Building and Evaluating Solutions for Next-Gen Cloud and Quantum Computing

Professor Rajkumar Buyya

Room: E6

The twenty-first-century digital infrastructure and applications are driven by Cloud computing and emerging Quantum computing paradigms. The Cloud computing paradigm has been transforming computing into the 5th utility wherein "computing utilities" are commoditized and delivered to consumers like traditional utilities such as water, electricity, gas, and telephony. It offers infrastructure, platform, and software as services, which are made available to consumers as subscription-oriented services on a pay-as-you-go basis over the Internet. Its use is growing exponentially with the continued development of new classes of applications such as AI-powered models (e.g., ChatGPT) and the mining of crypto currencies such as Bitcoins. To make Clouds pervasive, Cloud application platforms need to offer (1) APIs and tools for rapid creation of scalable and elastic applications and (2) a runtime system for deployment of applications on geographically distributed Data Centre infrastructures (with Quantum computing nodes) in a seamless manner. These wide ecosystems of cloud architectures integrated with new accelerators such as Quantum processing capabilities, along with the increasing demand for energyefficient IT technologies, require timely, repeatable, and controllable methodologies for evaluation of algorithms, applications, and policies before their implementation in cloud products. As utilization of real testbeds limits the experiments to the scale of the testbed and makes the reproduction of results an extremely difficult undertaking, alternative approaches for testing and experimentation leverage development of new Cloud technologies. A suitable alternative is the utilization of simulations tools, which open the possibility of evaluating the hypothesis prior to software development in an environment where one can reproduce tests. Specifically in the case of Cloud computing, where access to the infrastructure incurs payments in real currency, simulation-based approaches offer significant benefits, as it allows Cloud customers to test their services in a repeatable and controllable environment free of cost, and to tune the performance bottlenecks before deploying on real Clouds and quantum processors. At the provider side, simulation environments allow evaluation of different kinds of resource leasing scenarios under varying load and pricing distributions. Such studies could aid the providers in optimizing the resource access cost with focus on improving profits. This keynote presentation covers (1) 21st century vision of computing and identifies various emerging IT paradigms that make it easy to realize the vision of computing utilities, (2) different approaches for evaluation of resource management and application scheduling algorithms, (3) latest CloudSim 7G toolkit supporting modeling, simulation, and experimentation of emerging Cloud computing infrastructures and application services, (4) case studies on the use of CloudSim in development and evaluation of policies for (a) management of Cloud Data Centre resource to minimise energy-consumption, (5) use of Aneka 6G software system for scheduling of applications to minimise the cost of computation, yet meeting users QoS requirements, and (6) new directions on modelling and simulation of Quantum computing systems and applications.

Wednesday, November 26 11:45 - 12:30 (Pacific/Auckland)

K2: Keynote - Next-Generation Wi-Fi: Performance Issues and Research Challenges

Prof. Nurul Sarkar

Room: E6

There has been tremendous growth in the deployment of Wi-Fi technologies (IEEE 802.11 standards) in recent years. This growth is due to the flexibility, low cost, simplicity, and user mobility offered by the technology. Such

networks are being deployed widely in homes, offices, apartments, schools, shops, hotels, warehouses, factories, and almost anywhere that people live and work. This talk will highlight some of the most recent developments in Gigabit Wi-Fi such as the latest Wi-Fi 7 (802.11 be) and ongoing research activities in the next generation wireless network technologies. Network performance issues and challenges in protocol design and system deployment scenarios will be discussed. Empirical results will be presented to support the discussion. This is a knowledge-sharing talk suitable for a general audience.

Wednesday, November 26 12:30 - 13:30 (Pacific/Auckland)

L1: Lunch

Room: Foyer of Rātā | Engineering core

Wednesday, November 26 13:30 - 15:00 (Pacific/Auckland)

WS1: Workshop: Open RAN Security and Privacy: Opportunities and Challenges

Room: E6

Wednesday, November 26 15:00 - 15:30 (Pacific/Auckland)

AT1: Afternoon Tea

Room: Foyer of Rātā | Engineering core

Wednesday, November 26 15:30 - 17:30 (Pacific/Auckland)

S3: Session 3: Networks and General

Room: E6

15:30 ***Evolvable Network Design for Efficient Optical Intra-Datacenter Networks***

Takashi Miyamura (Senshu University, Japan); Shoichi Morimoto (Japan)

Ever-increasing traffic demand within datacenters (DCs) necessitates intra-DC network architectures that are scalable, energy-efficient, and cost-effective. In this paper, we introduce a novel, evolvable intra-datacenter network architecture that effectively utilizes wavelength selective switches (WSSs). By optimizing the network topology to minimize WSS cascading, our approach significantly reduces network cost and energy consumption. A key innovation is the evolvable network planning method, which enables us to scale dynamically while maintaining operational continuity and minimizing cost overhead. Intensive performance evaluations demonstrate that our proposed method reduces total energy consumption by approximately 6% and network cost by 26% compared to the conventional models. While the evolvable design introduces a modest 12% overhead in network resource usage compared to a static, green-field design, it guarantees service continuity during expansion. This research presents a practical framework for building future intra-DC networks that are both operationally flexible and economically sustainable.

16:00 ***An XML-Based Representation of a Drone Road System for Urban Areas***

Zhouyu Qu, Andreas Willig and Xiaobing Wu (University of Canterbury, New Zealand)

The applications of Unmanned Aerial Vehicles (UAVs) in urban environments have been expanding rapidly in recent years. This has led to an increasing number of drones in urban airspace, which could become an even more serious issue in the conceivable future, resulting in significant challenges for safety and traffic management. To address these challenges, one approach is to establish a road system for drones, similar to ground vehicle roads, to restrict their movements. In this paper, we propose a novel Drone Road System (DRS) design through an XML-based representation. It consists of four main attributes: road, ramp, lanes, and curves, which together provide high flexibility in system design. We also conduct a simulation study to evaluate the feasibility of applying our DRS design in urban environments. The results indicate strong potential for the proposed DRS to reduce collisions while sustaining efficient throughput in urban drone traffic

16:30 ***Feasibility of Delay-Based Scheduling to Solve Flock Formation of Drones***

Sujan Mario Warnakulasooriya, Andreas Willig and Xiaobing Wu (University of Canterbury, New Zealand)

To optimise the use of drones, flocking can improve the efficiency of task execution. Inter-drone collision avoidance is a critical requirement in any flocking algorithm. Conventional approaches typically adjust individual trajectories to prevent collisions. This paper investigates the feasibility of using a start delay-based scheduling method in which drones follow straight line trajectories with idealised velocity profiles. Two major constraints that may lead to circular dependencies are identified. The overall system relationships amongst drones are represented as an adjacency matrix, and the presence of cycles is evaluated using a standard topological sorting algorithm. Simulation results across fleet sizes from 25 to 5,000 drones determine the density ranges that support cycle-free scheduling, leading to the derivation of a density function ensuring that at least 95% of configurations remain cycle-free. The proposed analysis provides a foundation for collision-free flock scheduling and

establishes the basis for algorithms that assign individual time delays to drones whilst maintaining efficient operation.

17:00 ***Blind Phase-Offset Estimation via Equal-Angle Partitioning of the I/Q Plane***

Yooncheol Choi, Chisom Michael Onyekwelu and Dongweon Yoon (Hanyang University, Korea (South))

In digital communication systems, accurate phase-offset estimation is essential for recovering the transmitted information. While cooperative systems often rely on reference signals for this task, such prior knowledge of the transmitter is unavailable in non-cooperative contexts. Consequently, the receiver should estimate the phase offset solely from the received data symbols. This paper proposes a blind phase-offset estimator for phase modulated signals based on equal-angle partitioning of the phase and quadrature(I/Q) plane. Specifically, the I/Q plane is divided into equal-angle regions, and the received symbols in each region are rotated by the bisector angle of that region. The rotated symbols are then summed, and the angle of the resulting sum is taken as the phase-offset estimate. Using this estimate, the phase of all received symbols is compensated, and the procedure is repeated iteratively to improve estimation accuracy. Simulation results demonstrate that the proposed method outperforms conventional algorithms.

Wednesday, November 26 15:30 - 17:00 (Pacific/Auckland)

S4: Session 4: Network Applications

Room: E7

15:30 ***Serv-Drishti: An Interactive Serverless Function Request Simulation Engine and Visualiser***

Siddharth Agarwal, Maria A. Rodriguez and Rajkumar Buyya (University of Melbourne, Australia)

The rapid adoption of serverless computing necessitates a deeper understanding of its underlying operational mechanics, particularly concerning request routing, cold starts, function scaling, and resource management. This paper presents Serv-Drishti, an interactive, open-source simulation tool designed to demystify these complex behaviours. Serv-Drishti simulates and visualises the journey of a request through a representative serverless platform, from the API Gateway and intelligent Request Dispatcher to dynamic Function Instances on resource-constrained Compute Nodes. Unlike simple simulators, Serv-Drishti provides a robust framework for comparative analysis. It features configurable platform parameters, multiple request routing and function placement strategies, and a comprehensive failure simulation module. This allows users to not only observe but also rigorously analyse system responses under various loads and fault conditions. The tool generates real-time performance graphs and provides detailed data exports, establishing it as a valuable resource for research, education, and the design analysis of serverless architectures.

16:00 ***Privacy-Preserving and Efficient Model Training for Edge Healthcare Using Data Distillation Techniques***

Qaiser Razi (Birla Institute of Technology and Science, India); Amit Chougule (BITS Pilani, India); Sai Sesha Chalapathi G (Birla Institute of Technology and Science, India); Vikas Hassija (Kalinga Institute of Industrial Technology, India)

Data distillation is an efficient machine learning technique that generates a compact yet representative subset of a large dataset, reducing computational overhead while preserving essential features. This work proposes a novel state-of-the-art data distillation approach that enables model training on

significantly fewer data without compromising performance. Pneumonia and Brain Tumor datasets were used to evaluate the performance of distilled data using three machine learning models, i.e., ResNet50, MobileNetV2, and VGG16. The model is trained on the full dataset and the distilled subset, with a comparative performance analysis. Experimental results show that the distilled dataset achieves comparable accuracy to that of the full dataset. This demonstrates the efficiency of the proposed method in maintaining high predictive performance while significantly reducing memory usage, computational cost, and training time. Additionally, by minimizing data exposure, the method enhances data privacy and supports privacy-aware learning, which is crucial in sensitive domains like healthcare.The lightweight nature of the distilled data also makes the approach well-suited for deployment on edge devices, enabling on-device model training and inference in real-time, even in low resource environments.

16:30 ***Failure Mode and Effects Analysis (FMEA) for Geolocation AIR Systems***

Masood Mansoori (University of New South Wales, Australia); Junaid Haseeb (The University of Waikato, New Zealand); Ian Welch (Victoria University of Wellington, New Zealand)

Adversarial Information Retrieval (AIR) systems are designed to retrieve, index, and detect malicious web sites. These web sites in response, employ cloaking techniques such as geolocation cloaking to thwart or minimise detection by AIR systems. Therefore for an AIR system, it is essential to mimic attributes associated with a client appropriately to be subjected to the attack. This paper uses a systematic approach, i.e., Failure Mode and Effects Analysis (FMEA) to discuss logical and physical attributes which can influence and deviate a study on geolocation cloaking from its intended purpose and result in potential failure in detection. A set of actions have also been proposed to mitigate or minimise the likelihood or the effect of the failures.

Thursday, November 27

Thursday, November 27 9:00 - 11:00 (Pacific/Auckland)

S5: Session 5: Terrestrial and Non-Terrestrial Networks

Room: E6

9:00 ***Enhanced Doppler Based Localization in Mega Satellite Networks***

Zonghan Li, Bisma Manzoor, Jing Fu and Akram Al-Hourani (RMIT University, Australia)

With the growing reliance on global navigation satellite systems, the need for alternative localization methods has become critical. Doppler based localization is attracting increasing interest; however, its performance is constrained by a limited frequency resolution, which introduces noise and reduces positioning accuracy. This paper presents a novel Doppler extraction framework that integrates matched filtering, frequency agile filter, and a phase locked loop to mitigate these limitations. The estimated Doppler profile is used to localize a terrestrial network device based on the unique fingerprint captured by multiple satellites. We show that matched filtering and frequency agile filter enhances the frequency resolution, while the phase locked loop refines extracted frequencies by tracking phase deviation over time. The proposed approach is evaluated in a simulated satellite based localization scenario, demonstrating a significant improvement in localization accuracy compared to the Fast Fourier Transform based method. Monte Carlo simulations results show that employing four localization iterations and six satellites can achieve a reliable localization of network devices.

9:30 ***A Game-Theoretic Pricing Model for Integrated Terrestrial and Non-Terrestrial Networks***

Simbarashe Tanyanyiwa and Olabisi Emmanuel Falowo (University of Cape Town, South Africa)

The transition toward 6G in the telecommunications industry is driven by the need for ubiquitous global coverage which necessitates the seamless integration of Terrestrial Networks (TN) and Non-Terrestrial Networks (NTN). Historically, TN and NTN have advanced as separate networks with distinct standards, infrastructural requirements, cost structures, and pricing models, forcing users who need both services to maintain multiple subscriptions and billing arrangements. This multi-subscription model reduces efficiency and limits the commercial viability of integrated services. Given the high capital costs and global scope of NTN infrastructure, most NTN providers require partnerships with local Mobile Network Operators (MNOs) to leverage their existing subscriber base. This motivates the need for a unified, economically sustainable pricing framework that supports multi-operator interactions in Integrated Terrestrial and Non-Terrestrial Networks (ITNTN). This paper proposes a Stackelberg game-theoretic pricing model for an ITNTN that accommodates multiple LEO operators and an MNO with heterogeneous user requirements under quality-of-service (QoS) and budget constraints. In the proposed scheme, the MNO acts as the Stackelberg leader, setting end-user prices while procuring wholesale NTN resources from competing LEO operators. The model jointly optimizes radio resource acquisition, end-user pricing, and cross-domain reallocation to maximize MNO profit while ensuring affordability through price discrimination. User demand is modelled via budget-constrained utility maximization, capturing service heterogeneity, latency sensitivity, and willingness to pay. The performance of the proposed scheme has been evaluated through simulations. Results show that the approach enhances MNO profitability and enables a unified subscription model, eliminating the need for separate TN and NTN contracts, thereby ensuring seamless multi-domain connectivity.

10:00 ***Path-Selection Strategies for Inter-Satellite Routing in Mega Constellations*** PDF

Fritz Justin Crisostomo and Bisma Manzoor (RMIT University, Australia); Bassel Al Homsi (University of Sharjah, United Arab Emirates); Akram Al-Hourani (RMIT University, Australia)

The integration of inter-satellite links (ISLs) within Low Earth Orbit (LEO) constellations is anticipated to enhance global connectivity and reduce network latency. By enabling direct satellite-to-satellite communication, ISLs support in-orbit data relay and contribute to resilient network architectures. However, frequent path switching in dynamic topologies introduces latency variation (jitter), which degrades time-sensitive services. To address this challenge, we propose a novel delay-threshold path selection strategy that triggers a switch only when a candidate route outperforms the current path by more than a defined threshold, thereby jointly minimizing delay and jitter. Alongside this approach, we evaluate two baseline strategies: (i) dynamic shortest-path strategy that minimizes instantaneous delay, and (ii) persistent-path strategy that reduces handovers by maintaining the current path while feasible. Simulations on a Walker-Delta constellation show that the proposed strategy reduces jitter by 43% and handovers by 56%, while keeping mean end-to-end delay within 5% of the shortest-path baseline. These results demonstrate that the proposed strategy substantially improves temporal stability with minimal latency penalty.

10:30 ***Cellular-to-Aerial Downlink Coverage under Inter-Cell Interference***

Mohammed Elsagher and Akram Al-Hourani (RMIT University, Australia)

Unmanned Aerial Vehicles (UAVs) are emerging as agile IoT platforms for sensing and relaying, yet their elevated, Line of Sight (LoS)-rich vantage points make them unusually exposed to inter-cell interference in cellular-to-UAV links. This paper develops a tractable framework for quantifying connectivity under interference-limited conditions in both downlink and uplink. Using stochastic geometry, we derive a computable lower bound on coverage probability, explicitly capturing altitude, base-station density, and path-loss regimes typical of low-density urban settings. We expose how altitude dynamically trades LoS gains against aggregate out-of-cell leakage, yielding altitude bands that maximize coverage. Monte Carlo experiments corroborate the analysis and map performance across practical flight

envelopes. The results guide interference-aware flight planning and robust UAV-IoT deployment in existing cellular networks.

Thursday, November 27 9:00 - 11:00 (Pacific/Auckland)

S6: Session 6: 5G/6G technologies

Room: E7

9:00 ***OPTeSIM: Optimal Cellular Prepaid Plans for a Customer Base with eSIM-Capable Phones***

Ramneek Ramneek (Korea University, Korea (South)); Patrick Hosein (The University of the West Indies, St. Augustine, Trinidad and Tobago); Karandeep Singh (University of California Los Angeles (UCLA), USA); Sangheon Pack (Korea University, Korea (South))

The embedded subscriber identity module (eSIM) technology has the potential to revolutionize mobile subscribers' applications, transforming the method and pricing of service offerings from mobile operators. The influence of e-SIM is expected to be more significant in markets with a higher prevalence of prepaid customers. A typical prepaid plan places limits on data usage and the time it takes for these data to be used. To realize the potential of this offer, it is necessary to optimally design the service levels and associated prices. We propose an approach for optimally designing prepaid plans for a case of finite plan offerings. Given historical customer usage data, we determine the plans that maximize revenue for the provider using the proposed model, OPTeSIM. Customer usage data from two mobile network operators (MNOs) are used to illustrate the effectiveness of our proposed approach. It was observed that the current plans provided by MNOs exhibit suboptimal performance for both MNOs and users. On the contrary, the proposed model leads to improved profitability as compared to existing plans.

9:30 ***Congestion Control Scheme Based on Adaptive Transmission Regulation in LPWAN***

Takato Itoi (Nippon Institute of Technology, Japan)

With the spread of Internet of Things (IoT) systems, congestion on random access channel due to the traffic from numerous devices is expected to become an important issue. For licensed wireless networks, such as 4th Generation (4G) mobile phones Long Term Evolution (LTE) and 5th Generation (5G), the Third Generation Partnership Project (3GPP) has proposed and standardized congestion control mechanisms for random access channels transmitting sensor data. In contrast, congestion control in unlicensed Low-Power Wide Area Networks (LPWANs), such as LoRa and Sigfox, has not been sufficiently investigated due to the small packet size and low traffic volume at present. This study proposes an adaptive regulatory control scheme to suppress congestion in the random access channel of unlicensed LPWANs, which is a concern with the further spread of IoT devices. The throughput characteristics of the proposed congestion control scheme are validated through theoretical analysis and simulations, demonstrating its stability even under overload conditions.

10:00 ***Efficient Allocation of BBU Cards in Software-Enabled CRAN Using Transformer-Based Traffic Prediction***

Avigyan Samanta (Indian Institute of Technology Kharagpur, India); Shubham Chandrakant Poyekar (Research, India & Indian Institute of Technology Kharagpur, India); Amit Dutta (Indian Institute of Technology, Kharagpur, India); Aneek Adhya (Indian Institute of Technology Kharagpur, India)

Improving low-latency and energy efficiency performance in cloud radio access network (CRAN) architecture of 5G and beyond networks poses a significant challenge. To address these issues, in this paper, we propose a software-defined networking (SDN)-enabled CRAN system, referred to as low-latency proactive virtualized CRAN (LLP-VCRAN), where we use a 10-Gigabit-capable symmetric passive

optical network (XGS-PON) in the fronthaul. We implement a Transformer-based traffic prediction model coupled with an online bin packing model in the SDN controller to efficiently allocate BBU cards to RRHs before the arrival of traffic from the RRHs. The proposed system offers a significant reduction in end-to-end delay, especially in high-load conditions, along with increased flexibility in network operations.

10:30 ***Hierarchical GNN-based Task Offloading Optimization for Multi-Access Edge Computing***

Hengli Jin (University of RMIT, Australia); Shuo Li and Mark A. Gregory (RMIT University, Australia)

Mobile Edge Computing (MEC) enables low-latency processing for computation-intensive applications by offloading tasks from resource-constrained devices to nearby edge servers. Modern applications decompose into interdependent subtasks forming Directed Acyclic Graphs (DAGs). Such complex task dependencies and the dynamic physical wireless channel conditions make the optimization of task offloading decisions and resource allocation hard. In this paper, we propose a Hierarchical Graph Neural Network with Proximal Policy Optimization (HiGNN-PPO), a deep reinforcement learning framework that decouples physical infrastructure and logical task structure processing through dedicated graph attention networks. Our key innovation is a bidirectional cross-layer attention mechanism enabling adaptive information exchange: resource availability in the physical layer influences scheduling priorities while task characteristics guide resource selection. The framework employs temperature-controlled gated fusion to balance domain-specific and cross-layer features, with localized message passing enabling generalization to unseen DAG topologies without retraining. Experimental evaluation demonstrates that HiGNN-PPO reduces average application completion time and improves deadline satisfaction rates compared to both traditional heuristics and flat graph neural architectures, validating that hierarchical graph processing with cross-layer coordination effectively addresses the joint optimization challenge in dynamic MEC environments.

Thursday, November 27 11:00 - 11:30 (Pacific/Auckland)

MT2: Morning Tea

Room: Foyer of Rātā | Engineering core

Thursday, November 27 11:30 - 12:15 (Pacific/Auckland)

K3: Keynote - From Clouds for 5G Systems to Clouds for 6G Systems: A Bumpy Road Ahead

Professor Roch Glitho

Room: E6

Each generation of telecommunication systems brings additional levels of sophistication to the services offered to end-users. The Ultra Reliable Low Latency Communications (URLLC) services (e.g. remote robotic surgery) promised by the fifth-generation (5G) are compelling examples. They are a far cry from the Short Message Service (SMS) offered by the second-generation (2G), and the simple multimedia services offered the third and fourth generations (3G/4G). The deployment of 6G systems is expected for the 2030s, and much more sophisticated services (e.g. immersive holographic type - communications services) are expected. Clouds are the pillars of 5G and Beyond (5GB) due to the fact that features such as elasticity, scalability, and provisioning on-demand can successfully tackle the everlasting challenges such as lack of flexibility and over provisioning faced by telecommunication systems. 6G requirements are now known and are far more stringent than their 5G counterparts. Expected end-to-end latency for instance is now 0.1 milli-second instead of the 1 milli-second that is

hardly met nowadays. Clouds for 5G will certainly fail when it comes to meeting 6G challenges. Thus, the need of a new generation of clouds for 6G. However, the road ahead from clouds for 5G to clouds for 6G will certainly be bumpy due to the numerous challenges. In the first part of this keynote speech, we will introduce the expectations of 6G systems on clouds, and discuss why clouds for 5G cannot meet them. In the second part, we will sketch the research directions that may bring us to clouds for 6G. The third part will show that clouds alone will not be sufficient for 6G. It it will be necessary to complement them by other paradigms. In-Network Computing (INC) is a good candidate. This is likely to bring us to a paradigm of "cloud-edge continuum enriched by INC" for 6G.

Thursday, November 27 12:30 - 13:30 (Pacific/Auckland)

L2: Lunch

Room: Foyer of Rātā | Engineering core

Thursday, November 27 13:30 - 17:30 (Pacific/Auckland)

T1: Conference Tour

meet outside Building

Thursday, November 27 18:30 - 22:00 (Pacific/Auckland)

D1: Conference Dinner

Friday, November 28

Friday, November 28 9:00 - 11:00 (Pacific/Auckland)

S7: Session 7: 5G/6G

Room: E6

9:00 ***Handling Real-time Slice requests with QoS-aware Offline Optimization and Online Adaptation***

Hitesh Prajapati (Indian Institute of Technology Kharagpur, India); Dibbendu Roy (Indian Institute of Technology Indore, India); Goutam Das (Indian Institute of Technology, Kharagpur, India)

Network slicing in sixth-generation (6G) systems requires dynamic and priority-aware resource reconfiguration to satisfy service level agreements (SLAs) under varying traffic conditions. Existing optimization- and learning-based approaches often overlook scenarios where new slice requests cannot be accommodated by residual capacity, requiring controlled reallocation from existing slices. This paper develops a mathematical framework for slice reconfiguration that jointly allocates bandwidth and processing resources under end-to-end (E2E) delay and throughput constraints. Two offline formulations are presented: an auxiliary-variable model for exact constraint handling and a Softplus-based approximation that enables smooth gradient optimization. Building on the same structure, an online projected gradient method is introduced to adapt allocations when new slices arrive, ensuring priority-aware and graceful quality-of-service (QoS) degradation under fixed resource budgets. Simulation results show that the offline and online methods exhibit consistent allocation behavior, with the online approach enabling near real-time reconfiguration while the offline

formulations provide baseline references under complete demand knowledge. Index Terms-6G, network slicing, resource allocation, slice re-configuration, optimization, online algorithms, QoS management

9:30 ***Semantic-Aware MAC Scheduling for XR Traffic in 6G Networks***

Arjoon Chatterjee (Indian Institute of Technology Kharagpur, India); Diganta Ray Mandal (IIT Kharagpur, India); Sourav Dutta (Indian Institute of Technology Mandi, India); Goutam Das (Indian Institute of Technology, Kharagpur, India)

Extended Reality (XR) is emerging as a key class of immersive applications for next-generation networks. Reflecting it's importance, ITU-R IMT-2030 vision identifies XR as a key service class for 6G, and 3GPP has recognized XR as a critical use case. However, conventional schedulers such as Proportional Fair (PF), and MAX-CQI etc often fail to meet XR's ultra-low latency, high throughput, and high reliability demands. Existing frame-level integrated transmission strategies improve XR support by prioritizing frame completion but still focus on network-level Quality of Service (QoS), overlooking user-perceived Quality of Experience (QoE). Since not all XR data equally contribute to perceptual quality, semantic communication offers a promising solution by prioritizing semantically important content. In this paper, we propose a novel semantic-aware MAC scheduling framework for XR over 6G networks that integrates semantic relevance extracted using a 3D convolutional neural network (3D-CNN) for frame prediction with traditional network metrics to optimize resource allocation. Simulation results demonstrate significant QoE improvements and achieving higher gain compared to PF (upto 100%), MAX-CQI (upto 88%), and frame-level integrated schedulers (upto 87%).

10:00 ***Combating Coastal Shadowing for Ship-to-Shore Communication Using STAR-RIS aided NOMA***

Saurab Rauniyar (University of Oslo, Norway); Pål Orten (Kongsberg Maritime & University of Oslo, Norway); Stig Petersen (Sintef ICT, Norway)

With the rapid growth of maritime activity, maintaining reliable ship-to-shore connectivity faces growing challenges from shadowing caused by passing tall vessels, offshore structures, and other maritime obstructions. An analysis of data for one month from the Norwegian Coastal Administration Automatic Identification System (AIS) shows that shadowing occurs in more than (60%) of transmissions in Norwegian coastal waters. These frequent Non-Line-of-Sight (NLoS) conditions cause severe signal attenuation and undermine communication reliability. To address this, we investigate the use of Simultaneously Transmitting and Reflecting Reconfigurable Intelligent Surfaces aided Non-Orthogonal Multiple Access (STAR-RIS-NOMA) to enhance both coverage in (360^\circ) NLoS regions and system capacity. By simultaneously transmitting and reflecting incident signals, STAR-RIS can effectively reduce signal blockage and combat fading, while the integration of NOMA further enhances spectral efficiency. Simulation results show that STAR-RIS aided NOMA consistently delivers gains over conventional OMA schemes, improving near-user capacity by up to (5\ \text{bps/Hz}) in shadowed maritime scenarios. These results highlight STAR-RIS-NOMA as a scalable and practical solution for high-capacity, shadowing-resilient ship-to-shore communications.

Friday, November 28 9:00 - 11:00 (Pacific/Auckland)

S8: Session 8: Cybersecurity

Room: E7

9:00 ***A Practical Honeypot-Based Threat Intelligence Framework for Cyber Defence in the Cloud***

Darren Malvern Chin (Whitecliffe College, New Zealand); Bilal Ishfaq and Simon Yusuf Enoch (Whitecliffe, New Zealand)

In cloud environments, traditional firewalls block only known threats based on predefined rules and require manual configuration, which limits their adaptability to new attacks. With the growing adoption of platforms like Microsoft Azure, this static model leaves assets vulnerable to zero-day exploits, botnets, and advanced persistent threats. In this paper, we propose an automated defense framework that leverages medium-high interaction honeypot telemetry to dynamically update firewall rules in real time. We integrated deception sensors (Cowrie), Azure-native automation tools (Monitor, Sentinel, Logic Apps), and MITRE ATT&CK-aligned detection into a closed-loop feedback mechanism. We observed attacker tactics, classified them using established threat intelligence frameworks, and applied rapid network-level mitigation with minimal human intervention. We analyzed the data collected using security metrics, including Mean Time to Block (MTTB) and attacker engagement time. Building on existing frameworks, we extended adaptive, automated defense into the cloud. Our experimental results show an average MTTB of 0.86 seconds, significantly faster than benchmark systems, while classifying over 12,000 SSH attempts across multiple MITRE ATT&CK tactics. We demonstrate that combining deception telemetry with Azure-native automation can effectively reduce attacker dwell time, enhance SOC visibility, and deliver a scalable, actionable cloud defense strategy.

9:30 ***An Investigation of Feature-Grouping for Robust SHAP Explanations in IoT Intrusion Detection***

Dedy Hendro, Yi Mei and Ian Welch (Victoria University of Wellington, New Zealand)

The opacity of Machine Learning (ML)-based Internet of Things (IoT) Intrusion Detection Systems (IDSs) necessitates Explainable AI techniques like SHAP. However, SHAP explanations for models trained on high-dimensional, one-hot encoded data are fragmented and unstable, reducing their utility for security analysts. A recent method, FusionSHAP, has been introduced to aggregate SHAP values of the one-hot encoded features back into their respective semantic groups. FusionSHAP has been shown to improve the interpretability of the explanations. In this study, we extend the existing evaluation through quantitative and qualitative evaluation of feature grouping method across multiple dimensions. We investigate its effect on faithfulness, complexity and robustness, its performance across different ML models (Random Forest vs. XGBoost) and attack types (DDoS vs. Ransomware), and its superiority over label encoding. Our evaluation, conducted over 30 random seeds, demonstrates that feature-grouping: 1) perfectly preserves faithfulness; 2) significantly improves robustness (e.g., reducing worst-case sensitivity by 30% for Random Forest); and 3) outperforms label encoding in worst-case robustness, making it the safer choice. The trade-off of increased complexity is consistent across all experiments and is a favourable cost for the substantial gains in robustness and stability, which are paramount in cybersecurity context.

10:00 ***A Private Ethereum Testbed for Network Traffic Dataset Collection***

Zubaida Rehman and Mark A. Gregory (RMIT University, Australia); Iqbal Gondal (RMIT, Australia); Hai Dong (RMIT University, Australia); Mengmeng Ge (Monash University Australia, Australia)

Ethereum has emerged as one of the most widely used blockchain platforms, underpinning decentralized finance, smart contracts, and distributed applications. With its growing adoption, the Ethereum peer-to-peer network is susceptible to network-layer attacks including eclipse (node-isolation) attacks. To study the threats to Ethereum and to develop effective detection and mitigation strategies, researchers require controlled, reproducible, and labeled network datasets. However, datasets are scarce due to the complexity of capturing live blockchain traffic and the difficulty of confidently labeling malicious activity on public networks. In this paper, we present the design and deployment of a private Ethereum testbed for dataset collection. Our testbed consists of five virtual machines running Geth clients interconnected via a controlled gateway: four nodes act as benign Ethereum peers and one node acts as a malicious entity that performs eclipse attacks. The testbed emulates normal blockchain operations (block propagation, transaction exchanges, and peer discovery)

and adversarial scenarios focused on node isolation. Wireshark is deployed on the gateway to capture the network traffic, enabling us to record raw packet traces for benign and attack scenarios. The resulting dataset provides a comprehensive view of Ethereum network-layer behavior, with traffic labeled according to ground truth (node role and attack phase). We describe the testbed, the attack procedure for generating eclipse conditions, the capture and labeling pipeline, and potential uses of the dataset for intrusion detection and resilience analysis.

10:30 ***Beyond the Black Box: A Framework for Explainable and Attack-Resilient Federated Anomaly Detection in IIoT***

Andrea Pinto (Universidad de Los Andes, Colombia); Yezid E. Donoso (Universidad de los Andes, Colombia); Jairo A Gutierrez (Auckland University of Technology, New Zealand)

Federated Learning (FL) is a promising paradigm for anomaly detection in Industrial Internet of Things (IIoT) environments. However, existing FL frameworks suffer from vulnerabilities such as model poisoning attacks, privacy leakage, and a lack of model interpretability, which is critical for IIoT environments. This paper introduces a novel framework, Federated Learning with Explainable Anomaly Signals (FL-EAS), designed to overcome these limitations. FL-EAS fundamentally alters the federated learning process by exchanging compact, 21-dimensional feature vector derived from the reconstruction errors of local, explainable models, rather than raw model parameters. The framework incorporates a server-side supervised classifier to detect and reject malicious contributions, thereby ensuring attack resilience. By propagating explainability from the client edge to the global model, FL-EAS provides transparent, human-interpretable results. The efficacy of this approach is contextualized for evaluation using the physical process data from the BATADAL 2.0 dataset, demonstrating a state-of-the-art F1-score of 0.9511 on concealed attacks, and demonstrating its potential for secure, efficient, and trustworthy anomaly detection in real-world Cyber-Physical Systems.

Friday, November 28 11:00 - 11:30 (Pacific/Auckland)

MT3: Morning Tea

Room: Foyer of Rātā | Engineering core

Friday, November 28 11:30 - 12:15 (Pacific/Auckland)

K4: Keynote session: Beyond Electronics: Harnessing Light to Accelerate AI Workloads

Associate Professor Haibo Zhang

Room: E6

The rapid evolution of AI, particularly driven by the large language models and their widespread adoption across diverse domains, has led to an exponential surge in AI computational workloads. As deep learning models and training datasets continue to grow in scale and complexity, these workloads have become increasingly compute-intensive, memory-bound, and energy-hungry. While electronic accelerators such as GPUs and TPUs have significantly improved the computational throughput, their performance and energy efficiency are increasingly constrained by the slowing of Moore's Law and the end of Dennard scaling. Photonic computing and communication, which use light rather than electricity for computation and data transfer in the optical domain, have emerged as a compelling alternative to traditional electronic platforms. This keynote will explore how photonic technologies can address key bottlenecks in handling AI workloads from two complementary perspectives: (1) photonic computing, which enables fast and energy efficient execution multiply-and-accumulate

(MAC) and matrix multiplication operations that are at the heart of AI workloads; and (2) photonic communication, which leverages on-chip and chip-to-chip optical interconnects to overcome the memory bandwidth limitations and support scalable AI training and inference. By aligning device-level photonic capabilities with system-level architectural design, this talk will outline a forward-looking roadmap toward energy-efficient and high-performance photonic computing architectures to support next-generation AI workloads, positioning photonic technologies not as a replacement, but as a critical enabler for the next era of high-performance computing.

Friday, November 28 12:30 - 13:30 (Pacific/Auckland)

L3: Lunch

Friday, November 28 13:30 - 15:00 (Pacific/Auckland)

S9: Session 9: Wireless Networks

Room: E6

13:30 ***Ad-hoc network management using mixed reality hand-tracking manipulation***

Kouichi Genda (Nihon University, Japan)

Ad-hoc networks are expected for routine applications such as environmental monitoring in agricultural fields, as well as emergency scenarios including temporary connectivity during backbone network disruptions caused by natural disasters. However, because device-to-device connections are unstable due to power supply restrictions and frequent device failure, network operators face a heavy maintenance burden and require advanced management skills. To simplify network management, this study proposes an ad-hoc network management method incorporating mixed reality (MR) technology, enabling sub-optimal visualization and simple gesture manipulation. The network is visualized using virtual objects in the MR environment, where an MR goggle automatically selects an appropriate indicator among multiple options based on the usage environment. In addition, an ad-hoc network is updated by directly manipulating virtual objects in the MR environment with the operator's gestures, called hand-tracking. Fundamental operations for network visualization and updating were validated through experiments using HoloLens2 as an MR goggle. The results indicate that MR technology can simplify ad-hoc network management, offering a more intuitive and efficient approach for use in dynamic environments.

14:00 ***Optimizing Sensor Selection for Inter-Region Relocation in Dynamic Regions of Interest***

Buddhima Amarathunga, Jyoti Sahni and Alvin C Valera (Victoria University of Wellington, New Zealand)

Internet of Things-enabled Wireless Sensor Networks (IoT-WSNs) are increasingly deployed in dynamic environments such as disaster response and habitat monitoring, where autonomous and adaptive deployment is critical. In large-scale scenarios with multiple dynamic Regions of Interest (RoIs), full coverage is often infeasible, necessitating targeted deployment across sub-regions. Environmental changes due to climate or mission priorities can alter these RoIs over time, requiring inter-region relocation of sensor nodes. Efficiently reallocating nodes from surplus to deficient regions while minimizing movement and preserving coverage in donor regions is a key challenge. This paper proposes a two-step, fog-assisted, decentralized selection and re-deployment framework. A step-wise, Destination-Oriented Directed Acyclic Graph (DODAG)-based aggregation strategy transmits only a subset of node data, reducing network overhead. Multi-Criteria Decision Analysis (MCDA) is employed for sensor selection to balance conflicting objectives such as residual energy, mobility, and local coverage. Simulation results show that MCDA-based selections consistently approximate the Pareto front, with an average Quartile Deviation (QD) of 0.0009 in objective gap across all three criteria,

compared to 0.0129 for baseline methods, indicating a substantially lower spread. Across multiple region scenarios, the proposed approach improves coverage in target regions while limiting coverage loss in donor regions, with moderate relocation costs, demonstrating robust and balanced performance in dynamic inter-region relocation scenarios.

Friday, November 28 13:30 - 15:00 (Pacific/Auckland)

S10: Session 10: Working in Progress - 1

Room: E7

13:30 ***Detection of Fileless Malware through Network Traffic Analysis***

Ayesha Ajmal, Maryam Doborjeh Gholami Doborjeh and Jairo A Gutierrez (Auckland University of Technology, New Zealand)

The rapid growth of fileless malware raises a fundamental challenge to existing cybersecurity frameworks. These malwares operate entirely within a system's volatile memory without creating malicious files on the disk. This research aims to overcome a critical gap in Network Intrusion Detection System (NIDS) by proposing a novel hybrid deep-learning framework. Traditional signature-based detection methods prove ineffective against these memory-resident threats, consequently this investigation details advanced feature extraction methodologies which can identify fileless malware using Network Packet Capture (PCAP) files. This study will employ Design Science Research (DSR) integrating it with a Design-Oriented Machine Learning (DS-ML) methodology which ensures systematic and rigorous development and evaluation process. Key contributions of this research will be: 1) holistic development of feature extraction mechanism that effectively captures fileless malware behavior within network traffic, 2) proposing a hybrid deep-learning model for optimizing the detection techniques for fileless malware, and 3) constituting specific evaluation metrics to measure the accuracy of detecting fileless malware. The resultant framework will discuss the limitations that are present in the existing approaches that primarily focus on detecting file-based malware.

14:00 ***Real-time anomaly detection system for ERESS using time series analysis***

Tomotaka Wada, Ryuta Kameoka and Kazuya Mori (Kansai University, Japan)

We have proposed an emergency rescue evacuation support system (ERESS) that functions immediately after localized disasters such as fires or terrorist attacks. Previous behavior analysis methods used simple acceleration threshold values, resulting in poor anomaly detection accuracy. Accurate and rapid disaster detection is crucial for user safety. Previous ERESS systems integrated visual and sensor data for detection, but the integration method was simplistic, and detection relied on only instantaneous data, leading to inaccurate results. So there are problems that this system has its low reliability and slow detection in anomaly detection. To solve this problem, we propose a real-time anomaly detection system for ERESS using time-series analysis to improve the accuracy and speed of anomaly detection. Through experimental evaluation, we demonstrate that our proposed method outperforms existing methods in terms of detection accuracy and reduces detection time.

14:30 ***Context-Aware Network Resource Allocation for Industry 5.0 Applications***

Md Mashiur Rahman and Jiong Jin (Swinburne University of Technology, Australia); Suresh Palanisamy (Swinbourne University of Technology, Australia); Steve van Winckel (Sutton Tools Pty Ltd, Australia); Prem Prakash Jayaraman (Swinburne University of Technology, Australia); Asif Ahmed Sardar (Indian Institute of Technology, Kharagpur, India)

Digital twins (DTs) have emerged as indispensable assets for monitoring and control within industrial environments, particularly in the context of human-centric smart manufacturing. The effectiveness of

DTs relies on how accurately the virtual model reflects its physical counterpart, a challenge exacerbated by constrained network resources, unpredictable communication channels, and rapidly changing factory conditions. In this study, synchronization fidelity is established as the primary objective for resource scheduling in an on-premises private 5G network. Our approach applies a context-aware resource blocks (RBs) allocation mechanism that connects the communication demands of Industry 5.0 applications and real-time operational variability to the network behaviour. This work-in-progress paper presents a system architecture that employs dynamic prioritization for resource allocation and lightweight extrapolation strategies to address data blind spots, thereby preserving digital twin fidelity as shop floor conditions evolve.

Friday, November 28 15:00 - 15:30 (Pacific/Auckland)

AT3: Afternoon Tea

Room: Foyer of Rātā | Engineering core

Friday, November 28 15:30 - 17:00 (Pacific/Auckland)

S11: Session 11: Working in Progress - 2

Room: E6

15:30 ***Green-Aware Dependent Task Offloading and Service Caching with Energy Sharing in MEC***

Hilal Ibrahim Sulieman Alawneh and Sieteng Soh (Curtin University, Australia); Kit Chan (Curtin University of Technology, Australia); Kwan-Wu Chin (University of Wollongong, Australia); Bilal Abu-Salih (The University of Jordan, Jordan)

We study dependent task offloading in renewable-powered multi-access edge computing (MEC). We propose GDTO/SC, a novel problem to jointly (i) offload tasks across edge servers and a cloud, (ii) decide which services to cache on edge servers that have limited resources, and (iii) utilize energy transfers of harvested green energy among edge servers under application-delay constraints. Its objective is to maximize green energy usage. We formulate G-DTO/SC as a mixed-integer linear program (MILP). We analyse the complexity of the MILP in terms of the total number of decision variables and constraints. We aim to present an empirical evaluation of the MILP in the extended version of this paper, which reports optimal results across multiple topologies and sensitivity to energy and edge server cache capacity limits with baseline comparisons. We envisage the MILP would be able to solve only small instances of the problem due to its complexity. Thus, next, we will design a heuristic solution to solve large instances of the problem.

16:00 ***Explaining Cyber Attacks Captured on Honeypots Through Attacker Issued Commands***

Daniel McAlpine and Junaid Haseeb (The University of Waikato, New Zealand); Vimal Kumar (University of Waikato, New Zealand)

The growing scale of cyber attacks demands automated behavioural analysis to enable timely mitigation. Current approaches often rely on Cyber Threat Intelligence (CTI) reports and Common Vulnerabilities and Exposures (CVE) descriptions, but these depend heavily on expert input, introducing subjectivity and limiting scalability. We propose an automated method that analyses honeypot-captured attacks by mapping Shell commands to Linux man page descriptions and aligning them with the MITRE ATT&CK framework using the Semantic Mapping of Exposures to Techniques (SMET) tool. To

provide richer context, command descriptions are also chained into reports. Evaluation on a public dataset achieved up to 82% similarity with manual annotations

16:30 ***A vehicle self-localization method utilizing reflector code recognition using LiDAR on vehicle***

Tomotaka Wada, Naoki Azuma and Tao Yang (Kansai University, Japan)

Determining a vehicle's precise location is very important. However, GNSS signals can become unstable in areas such as tunnels or urban areas. Therefore, this research proposes a system for estimating a vehicle's position by embedding GNSS information within a reflective code, which consists of a reflective material attached to a cylindrical object resembling a utility pole. The distance to the pole and the GNSS data are acquired using LiDAR and GNSS receiver, and the vehicle's position is calculated. GNSS data within 5m to 10m range from the pole is pre-recorded, and the estimated position is compared with the actual position when the vehicle passes that location. This method offers the advantage of providing accurate position information even in areas where GNSS signals are unreliable or inaccurate, such as tunnels or urban areas. Field tests using an actual vehicle were conducted to verify the accuracy of the proposed position estimation method.

Friday, November 28 15:30 - 17:00 (Pacific/Auckland)

S12: Session 12: Online session

Room: E7

15:30 ***Tracking Reference Signal Periodicity and Energy Consumption: Trade-offs in 5G Networks***

Jui Mhatre and Ahyoung Lee (Kennesaw State University, USA)

Tracking reference signals (TRS) are essential in the 5G New Radio (NR) physical layer for enabling user equipment (UE) to maintain synchronization and accurately estimate channel state information (CSI), especially under high mobility or at higher frequencies. TRS are transmitted periodically by the base station (BS), but this periodicity introduces an energy trade-off. Frequent TRS transmissions improve synchronization and reduce bit error rate (BER), particularly for fast-moving UEs. However, they also increase BS transmission energy and prevent UEs from entering low-power sleep modes, thereby increasing UE energy consumption due to constant TRS processing. On the other hand, less frequent TRS transmissions reduce BS energy overhead and allow UEs to conserve energy by remaining idle longer. However, this can lead to clock drift and reduced synchronization accuracy at the UE, resulting in higher BER and increased data retransmissions, which also consume energy. This paper investigates how TRS periodicity affects energy consumption at both the BS and UE ends using MATLAB's 5G Toolbox. Simulations are conducted under various UE mobility scenarios, with TRS periodicities ranging from 10 ms to 80 ms. Results show that while lower periodicities ensure better synchronization and reliability, they burden the BS and disrupt UE sleep cycles. Conversely, higher periodicities benefit the BS but increase energy costs at the UE due to synchronization loss. The study highlights the critical trade-off between network energy efficiency and communication robustness, providing guidance for selecting TRS configurations in energy-aware 5G deployments.

15:52 ***Enhancing Cyberattack Detection using Machine Learning Techniques in Intrusion Detection Systems***

Kirushnaamoni Ramakrishnan and Taniela Vaipulu (Auckland University of Technology, New Zealand)

Early detection of network security issues can save significant time and resources. Traditional IDSs identify typical incidents, but AI has increased the effectiveness of attacks, making them harder to

detect. Most research focuses on analyzing a single dataset divided into training and testing sets. While this method effectively measures the accuracy of machine learning-trained IDS models, it may not reflect how the model performs in real-time scenarios. This is important because the IDS should be capable of identifying unknown attacks. This study addresses this gap by conducting cross-source testing with two datasets: UNSW-NB15 for training and CIC DDoS 2019 for testing. The IDS was evaluated using Random Forest and Logistic Regression algorithms. Random Forest achieved higher accuracy, with 78% on the imbalanced dataset and 76% on the balanced dataset after feature selection. Future work could include employing artificial neural networks, deep learning techniques, alternative feature selection methods, and additional datasets to further improve IDS performance.

16:14 ***The End of the Bandwidth Era and the Rise of the Latency Era: A Conceptual Framework for Redefining Internet Quality in the Kingdom of Bahrain***

Sameh Foulad (University of Bahrain, Bahrain)

Bahrain has invested heavily in nationwide fiber networks, with a regulatory mandate ensuring a minimum of 300 Mbps for all fixed broadband packages. While bandwidth is no longer a bottleneck, users increasingly encounter performance issues caused by latency, especially when accessing international content. This paper introduces the \textit{Latency Era Model}, a conceptual framework built on three pillars: Last-Mile Optimization, International Route Intelligence, and Edge Infrastructure Expansion. Applied to Bahrain, the model shows how current infrastructure outpaces service quality due to limited CDN presence, reliance on distant upstream providers, and fragmented ISP coordination. The framework highlights latency as the defining factor in internet quality, offering practical guidance for ISPs and regulators to reorient strategies beyond speed upgrades toward sustainable latency-focused performance improvements.

Friday, November 28 15:30 - 17:00 (Pacific/Auckland)

S13: Session 13: Online Session - 2

Room: E5

15:30 ***eBPF-based Observability for Serverless WebAssembly Workloads***

Yinan Hu and Miika K.T. Komu (Ericsson Research, Finland); Timo Simanainen and Jimmy Kjällman (Ericsson, Finland)

WebAssembly (Wasm) is a promising fit for serverless environments because it can provide faster cold-start times than Linux containers. While serverless Wasm based applications could be observed and diagnosed for bugs and performance issues using OpenTelemetry, we propose an alternative solution that aims to avoid explicit instrumentation based on Extended Berkeley Packet Filter (eBPF). We implement a prototype of an observability framework for serverless Wasm workloads running in Kubernetes using the SpinKube framework. Our key contribution is an eBPF agent that collects data from the Wasm workloads. Our performance evaluations show that our solution introduces a latency average overhead of 17.8% and a maximum CPU overhead of 8%.

15:50 ***Optimizing Computation Offloading with Explainable Multi-Agent Deep Q-Networks***

Samarakoon Mudiyanselage Rasini Pamoda Amarasooriya (RMIT, Australia); Mark A. Gregory and Shuo Li (RMIT University, Australia)

Computation offloading in Mobile Edge Computing (MEC) is essential for IoT networks, but state-of-the-art Deep Reinforcement Learning (DRL) models suffer from high-dimensional state spaces that increase complexity and hinder efficiency. This paper proposes a novel framework integrating Explainable AI (XAI) with a Multi-Agent Deep Q-Network (MADQN) to optimize offloading in multi-

server environments. Our approach utilizes a Centralized Training with Decentralized Execution (CTDE) architecture and leverages SHAP (Shapley Additive Explanations) to perform iterative feature selection, systematically identifying and removing less impactful state features. Experimental results demonstrate that our full model achieves a 69.2% task completion rate, significantly outperforming heuristic baselines like Random (40.4%) and Round-Robin (35.5%). Crucially, the SHAP-simplified model, despite using 19.4% fewer features, attained a completion rate of 67.2%, a marginal 2-percentage-point decrease from the full model. This work validates that XAI-driven model simplification can substantially reduce computational complexity with a negligible impact on performance, offering a path toward more efficient and scalable multi-agent systems for edge networks.

16:10 ***Autocorrelation Reinforcement Learning for Non-Stationary Power-aware Wireless Body Area Networks***

Da-Ren Chen (National Taichung University of Science and Technology, Taiwan)

In this paper, we propose a autocorrelation reinforcement learning for QoS wireless body area networks (WBANs) based on link adaptation (LA), which designed for non-stationary channel status where sensors have limited computational capabilities. The proposed scheme leverages Signal-to-Noise Ratio (SNR) and transmit power to effectively exploit the most energy-efficient modulation-and-coding schemes (MCS) while satisfying target QoS without configuration tuning. The models, including power, SNR and pathloss and shadowing are applied to compute the length of sliding window and autocorrelation statistics to determine appropriate MCS. An effective Thompson Sampling (GTS) is applied to the proposed method. The proposed method can adapt the channel conditions surrounding the human body to achieve significant power savings, with transmit energy reductions of up to 12.2%. Additionally, it extends the operating time of the sensors by up to 25.4% compared to existing methods.

Friday, November 28 17:00 - 17:15 (Pacific/Auckland)

CR: Closing Remarks

ITNAC 2026 is in Melbourne, Australia

Himanshu Agrawal, General Co-Chair, Curtin University

Room: E6